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Quarterly Progress Report, Mar 1993 - May 1993  
ONR Contract Number N00014-91-J-1577  
Drew McDermott, PI  
Yale University Department of Computer Science

During this period, we continued our work on perception and planning for autonomous agents.

- We designed and implemented algorithms for visual tracking and for grasping objects of unknown shape from visual data. These are being written up.
- We proved the correctness and completeness of a decision-making algorithm based on interval analysis. We were able to show that the procedure is essentially a decision procedure except for a very small set of cases that almost never arise in practice. These results were written up and submitted to *Interval Computations*.
- We redesigned and reimplemented our time map for projecting robot plans. The biggest enhancement was to add Poisson-distributed autonomous events. You can now model the actions of other agents with rules like  $(P \rightarrow E \ A \ t \ B)$ , which states that over any time interval where  $A$  is true, the average time to the next occurrence of  $B$  is  $t$ . The next problem is to prove the algorithm correct; technical subtleties arise.
- We have begun to rethink our notion of runtime planning. Currently the planner executes its entire plan simultaneously with the attempt to improve it. If the improvement attempt succeeds, the new version is swapped in. What we would like to do is provide alternative ways to interleave planning and execution, so that some planning can be deferred until runtime. We are exploring how to add a **RUNTIME-PLAN** statement to RPL, our plan language.

**Activities:**

Gregory Hager, presentation at IEEE Conf. on Robotics and Automation, May  
Drew McDermott, "Planning is Automatic Programming for Agents," invited talk at the AAAI Spring Symposium, March 22-24  
Drew McDermott, "Transformational Planning of Reactive Behavior," Brandeis University, April 8

**Publications:**

Gregory Hager, Sean Engelson and Sami Atiya, "On Comparing Statistical and Set-Based Methods in Sensor Data Fusion", *Proc. IEEE Conf. on Robotics and Automation*

**Personnel Support:**

- *Graduate Students (full time)*: Sean Engelson, Michael Beetz, and Pedro Marun
- *Post-doc (half-time)*: Hemant Tagare
- *Secretary (half-time)*: Paula Murano

**Expenditures:**

The accompanying table shows the figures for expenditures to date, including amounts committed but not actually spent.

**Overall Status and Plans:**

We hope to get some more empirical data over the summer on the performance of the on-line planner. We are working to prove that the time map is actually statistically correct. The runtime planning system is being overhauled.

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LEDGER DESCRIPTION	AMOUNT BUDGETED	COMMITTED (NOT PAID)	PAID TO DATE	TOTAL EXPENSES	REMAINING BALANCE
PRINTING	0		313.80	313.80	-313.80
MISC SERVICES		270		270	-270
COMMISSIONS	0		25.00	25.00	-25.00
OTHER PROFESSIONAL	0		152.32	152.32	-152.32
DP EQUIP MAINTENANCE	0		581.16	581.16	-581.16
TRAVEL (DOMESTIC)	12,860	1,753.05	13,752.34	15,505.39	-2,645.39
TRAVEL (FOREIGN)	0		2,913.98	2,913.98 -2,913.98	
CONFERENCE & SEMINAR FEES		375.00		375.00	-375.00
OFFICE SUPPLIES	3,215	30.00	1,009.57	1,039.57	2,175.43
PERIODICALS	0	127.00	1,576.89	1,703.89	-1,703.89
POSTAGE	0	202.57	1,089.41	1,291.98	-1,291.98
DUES & MEMBERSHIP	0		160.00	160.00 -160.00	
TUITION REMISSION	69,162		21,436.00	21,436.00	47,726.00
HEALTH INS.	0		1,191.00	1,191.00	-1,191.00
TELEPHONE	3,215	175.00	557.31	732.31	2,482.69
DATA PROC. EQUIPMENT	189,000	27,208.60	74,834.65	102,043.25	86,956.75
INDIRECT (OVERHEAD 64.0%)	212,215	44,627.12	172,286.20	216,913.32	-4,698.32
TOTAL:	782,458	141,565.61	524,345.40	665,911.01	116,546.99
OVERHEAD ANTICIPATED:					45,481.75
SPENDING BALANCE AVAILABLE AS OF JULY 28, 1993:					71,065.24

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**DTIC QUALITY INSPECTED 3**

LEDGER DESCRIPTION	AMOUNT BUDGETED	COMMITTED (NOT PAID)	PAID TO DATE	TOTAL EXPENSES	REMAINING BALANCE
NON-LADDER ACAD \$ RES APPTS	0	1,790.82	8,954.10	10,744.92	-10,744.92
FACULTY SUMMER COMP	51,599	36,577.78	50,377.56	86,955.34	-35,356.34
MANAGERIAL & PROFESSIONAL	0 2,668.82	492.69	3,161.51	-3,161.51	
CLERICAL & TECHNICAL	25,719		35,334.00	35,334.00	-9,615.00
STUDENT ASST.	135,450	9,192.28	50,977.10	60,169.38	75,280.62
DIRECT WAGES	0		344.00	344.00	-344.00
OTHER YALE STU- DENTS	0		15,632.00	15,632.00	-15,632.00
EMP. BENEFITS	29,014	12,649.85	30,147.36	42,797.21	-13,783.21
D/P SUPPLIES	0	404.00	2,978.78	3,382.78	-3,382.78
MINOR EQUIPMENT & FURNISHINGS	0		379.00	379.00	-379.00
MISC MATERIALS	0		55.17	55.17	-55.17
D/P SVS.	38,579	3,750.00	28,951.00	32,701.00	5,878.00
D/P SOFTWARE	6,000		2,633.00	2,633.00	3,367.00
FREIGHT & TRANSPORTATION	0		821.47	821.47 -821.47 ->	
PHOTOCOPYING	6,430	33.72	4,118.54	4,152.26	2,277.74